Department of Environmental Protection
Bureau of Land & Water Quality - April 2003

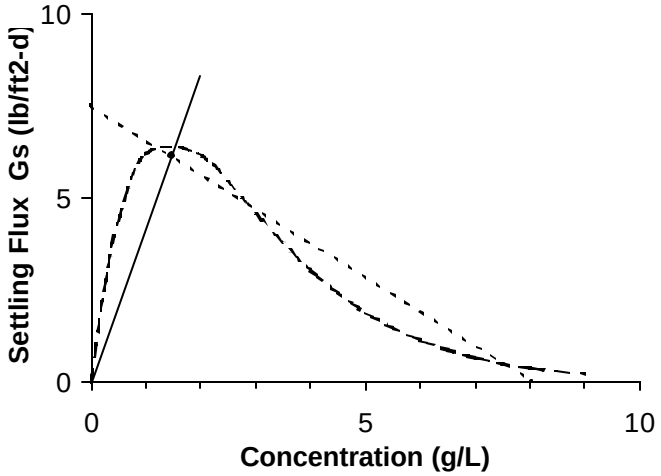
O&M Newsletter

A monthly newsletter for wastewater discharge licensees, treatment facility operators, and associated persons

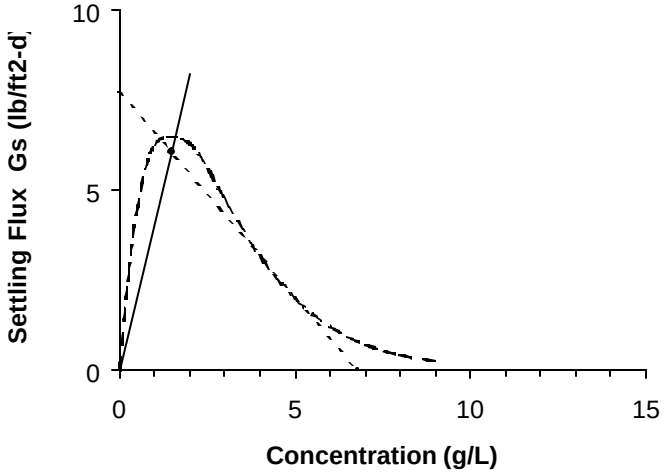
Clarifier Performance – Article 4 of 4

In our article last month, we showed how the different lines and curves of the State Point Analysis curve change as the operation of the clarifier changes. We also showed you how you can use the State Point Analysis chart to learn some things about how your clarifiers work and put that knowledge to use in your facility. This month we'll give a concrete example of how State Point Analysis was used to diagnose and solve a "Real-World" clarifier problem. We'll also discuss some models that have been developed to plot the Veslind curve (the up-down curved part of the State Point Analysis chart) based on sludge Volume index (SVI).

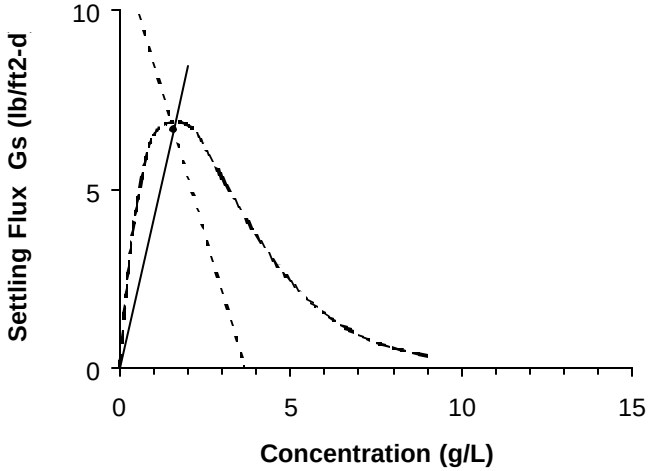
We'll start our "Real-World" example by describing the situation at the facility. This is a large municipal facility with a daily flow of between 53 and 55 MGD. The facility had three 215-ft. diameter, 16-ft. deep circular clarifiers. Technical assistance was requested when the system began loosing solids. At that time, the flow was 54.4 MGD, the SVI was 375 mL/g, the RAS flow was 12.2 MGD and the MLSS was 1470 mg/L. As the curve below shows, the clarifiers were overloaded with the Solids Underflow line clearly to the right of the Veslind curve.



The technical assistance troubleshooter immediately advised the operator to increase the RAS flow. Reluctantly, the operator turned the RAS flow up to 14.8 MGD while influent flow decreases to 53.5 MGD. RAS flow increased from 22% to 28% of influent flow. At the same time, the SVI improved slightly to 369 mL/g and the loss of solids lowered the MLSS to 1354 mg/L. As the graph below shows, the system is now in equilibrium and no more solids were being lost.

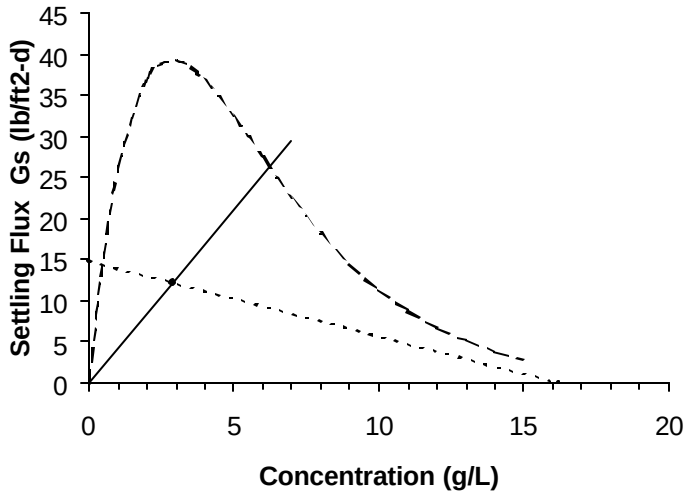


The technical assistance troubleshooter finally convinced the operator to increase the RAS flow even more. The operator turned the RAS flow up to 41.5 MGD while influent flow increased to 55.1 MGD. RAS flow increased from 28% to 75% of influent flow. At the same time, the SVI got slightly worse at 380mL/g while the MLSS increased to 1580 mg/L because more solids were being returned to the aeration tanks. The operators also increased wasting to remove solids from the clarifier. As the graph below shows, the blankets are staying in the clarifier.



Once the solids were staying in the clarifier, the technical assistance troubleshooter worked with the operator to improve the sludge quality and get the SVI under control. Over the course of a few weeks, through a combination of wasting, dissolved oxygen control and RAS control, the plant was brought to the following condition: Flow at 55 MGD with a RAS rate of 12 MGD (the original 22% RAS rate); MLSS at 2900 mg/L (with better BOD removal); and, SVI at 122 mL/g.

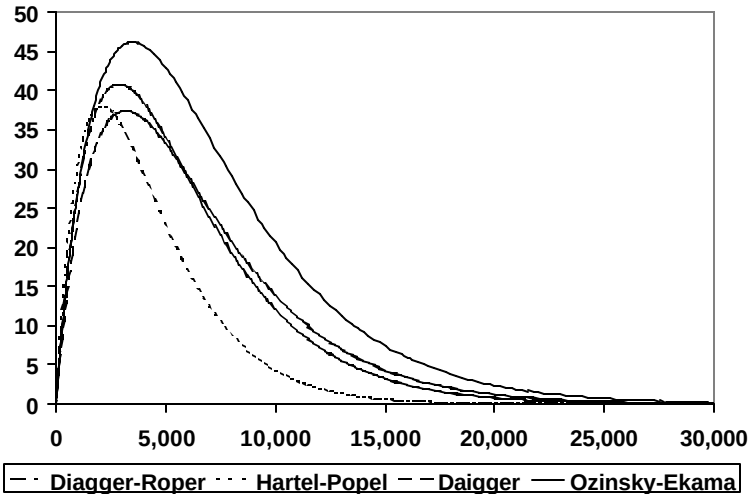
The graph for this operating state is shown below. The system is obviously running much better.



In this particular "Real World" example, the technical assistance troubleshooter did not have the settling velocity data necessary to develop the Veslind curve. In this case, he used one of several models developed by researchers that allow you to draw the Veslind curve as a function of SVI. Two of these models were developed by Dr. Glen Diagger and others while the other two were developed by Drs. Hartel and Popel in 1992 and by Drs. Ozinsky and Ekama in 1995. The equations developed by these researchers rely on data taken at several wastewater treatment facilities over some period of time. These data were "fit" to give the V_o and k factors needed to plot the Veslind curve

In Dr. Diagger's first equation, V_o is 7.8 m/hr (614.173 ft/day) and k is 0.148 + 0.00210 x SVI. In Dr. Diagger's second equation, V_o is 6.495 m/hr (511.417 ft/day) and 0.1646 + 0.001586 x SVI. In the equation developed by Drs. Hartel and Popel, $V_o = 17.4 \times e^{[(-0.0113 \times SVI) + 3.931]}$ and $k = 1.043 - 0.9834 \times e^{[-0.00581 \times SVI)]}$. The fourth equation, developed by Drs. Ozinsky and Ekama, gives $V_o = 8.53094 \times e^{[-0.00165 \times SVI]}$ and k = 0.20036 - 0.00091 x SVI.

The graph below shows a comparison of the Veslind curves generated by the four methods.



While the curves shown on the last page are very similar, they may or may not compare well with Veslind curves developed by using actual settling date. One reason for this may be that the SVI data that forms the basis for these curves was collected using the recommended procedure in "Standard Methods", which specifies using a l liter graduated cylinder rather than a one or two liter settleometer. Most operators in Maine and other northeast states use settleometers to determine the 30-minute settling volume and thus, the data may be somewhat different.

For troubleshooting purposes, use of one of the models will probably give a Veslind curve that is "close enough" and that will tell the troubleshooter what process change to recommend and what effect that change will have on the performance of the clarifiers. However, for day-to-day process control, actual settling data is far superior to using any of the Models.

Staff members from the Facility Operations Assistance Section (FOAS) of the New York Department of Environmental Conservation (NYDEC) have developed a fairly simple methodology for operators to perform the settling tests and develop the Veslind curves under various operating conditions. With enough of this settling data and corresponding SVI data, an operator could develop an equation to fit his/her facility's characteristics. That equation would probably be somewhat different than any of the curves described before, but it would be a better tool for the operator to predict the performance of his/her facility.

If you want more information about the SVI models or the methodology developed by the NYDEC FOAS staff, contact Dick Darling at 287-7806 or by e-mail at dick.darling@maine.gov.

For Practice

1. What is the sludge concentration at which pumping becomes difficult?

    a. 10%
    b. 5%
    c. 2%
    d. 1%

2. To control an Activated Sludge Process using MLVSS, the operator must maintain
    a. A constant concentration of suspended solids in the aeration tank.
    b. A constant concentration of volatile suspended solids in the return sludge.
    c. A constant concentration of volatile suspended solids in the waste sludge.
    d. A constant concentration of volatile suspended solids in the aeration tank.

3. The common parameter mg/L (milligrams per liter) is the same as
    a. Grains/Gallon
    b. parts per million (p.p.m.)
    c. ounces per pound
    d. grams per cubic foot

4. An operator doses the effluent from his plant with 6 mg/l of chlorine. If the flow through the plant averages 2.5 MGD, how much chlorine will be used in 30 days?
    a. 146 pounds
    b. 525 pounds
    c. 3,753 pounds
    d. 4,378.5 pounds

BOD & METABOLISM / DENITRIFICATION

Friday June 27, 2003, 8:30 AM – 4:00 PM
Registration 8:00 – 8:30 AM
DES Auditorium, Concord, NH

BOD & Metabolism This 3-hour session reviews the different types of BOD that enter the activated sludge process. The removal, degradation, transformation and loss of BOD are discussed. The degradation of BOD to non-polluting wastes and less polluting wastes and transformation of BOD (sludge production) are reviewed through aerobic, anoxic, and anaerobic respiration. The production of malodors through anaerobic respiration is presented. Operational measures for monitoring BOD degradation and sludge production as well as process control measures to reduce sludge production are presented.

Denitrification This 3-hour session reviews the biological principles of denitrification and their application for process control, troubleshooting, permit compliance, and cost-effective operation. Operational conditions affecting denitrification will be presented. This session will focus upon the benefits of desired denitrification and the unfortunate consequences of undesired denitrification. Topics include the sources of nitrite and nitrate ions, the anoxic environment, comparison of aerobic and anoxic respiration, monitoring denitrification, and controlling undesired denitrification.

Instructor Michael H. Gerardi, M.S., biology, is responsible for the development and presentation of wastewater biology courses for Penn State University.

Sponsor New Hampshire Water Pollution Control Association. Call 271-2940 for more info.

BOD & METABOLISM / DENITRIFICATION
Registration deadline is June 13, 2003

COST: ? $60 per registrant / NHWPCA members
? $85 per registrant / non members

Name _____

Facility or firm_____

Address_____

City_____State_____Zip_____Phone_____

? Payment enclosed or P.O. #_____

MAKE CHECK PAYABLE TO: NHWPCA

Mail completed registration with payment or P.O. # to:
Brian Hilliard, NHWPCA
P.O. Box 95, Concord, NH 03302-0095

Approved Training

April 15, 2003 in Augusta, ME - Seeded BOD, E. Coli, Solids and Microscopic Examination – A hands on lab review - Sponsored by JETCC, (207) 253-8020 – Approved for 6 hours.
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April 17, 2003 in Waterville, ME – Hands-On Confined Space Entry and Non-Entry Rescue - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
*****

April 17, 2003 in Brunswick, ME – Wastewater Treatment Certification Review Grades IV & V - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
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April 30, 2003 in Brewer, ME - Confined Space Entry - Sponsored by JETCC, (207) 253-8020 – Approved for 6 hours.
*****

April 30, 2003 in Hallowell, ME – Excavation: Competent Person Training - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
*****

May 1, 2003 in Bangor, ME – Wastewater Treatment Certification Review Grades IV & V - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
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May 1, 2003 in York, ME – Excavation: Competent Person Training - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
*****

May 7, 2003 in Bangor, ME – Wastewater Treatment Certification Review Grades I-III - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
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May 6, 2003 in Saco, ME - Physical Chemical Wastewater Treatment - Sponsored by JETCC, (207) 253-8020 – Approved for 6 hours.

May 8, 2003 in Presque Isle, ME – Wastewater Treatment Certification Review Grades IV & V - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
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May 6, 2003 in **TBA**, ME – Pumps & Pump Station Maintenance and Diesel Generator O & M - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
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May 7, 2003 in **TBA**, ME – Pumps & Pump Station Maintenance and Diesel Generator O & M - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
*****

May 8, 2003 in Presque Isle, ME – Wastewater Treatment Certification Review Grades I-III - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
*****

May 15, 2003 in Mexico, ME – Hands-On Confined Space Entry and Non-Entry Rescue - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
*****

May 21&22, 2003 in Bangor, ME, - Basic Lab Procedures w/ NEWEA Exam - Sponsored by NEIWPCC, (978) 323-7929 – Approved for 10 hours.
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May 20, 2003 in Houlton, ME – Excavation: Competent Person Training - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
*****

May 21, 2003 in **TBA**, ME – Excavation: Competent Person Training - Sponsored by MRWA (207) 729-6569 – Approved for 6 hours.
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December 2&3, 2002 in Freeport, ME - MRWA Annual Conference – Sponsored by MWRA, (207) 729-6569 – Approved for TBA hours.

NIST thermometer certification

Options for the wastewater treatment plant operator.

Earlier this year a treatment plant operator asked our staff if each of the thermometers used in his lab had to be NIST-traceable annually to meet QA/QC requirements. Here is a list of the options available to meet the requirements for assuring the thermometers in your lab are measuring temperatures accurately.

- Option 1: Have each of your thermometers NIST certified annually. This is the most expensive option.

- Option 2: Buy disposable NIST certified thermometers and replace them yearly or when the certification expires. This can also be an expensive option. The Department does not recommend buying mercury thermometers and throwing them out every year. Disposable thermometers that use alcohol are a more environmentally sound alternative.

- Option 3: Have one of your thermometers NIST certified every year, compare the rest of the thermometers in your lab to this one at least annually and keep a written record of the comparison results. Readings from thermometers that are found to be off can be adjusted based on this comparison. The Department recommends replacing any thermometers that are off by more than 1°F. Remember, NIST certifies thermometers at certain points - [104°C(TSS), 44.5°C(*E.Coli*), 20°C(BOD), 4°C(refrigerator)]. Cost is approximately $40/point. If you want to use a single thermometer to check all your other thermometers then you must have it NIST certified for multiple points. If several adjacent treatment plants would like to get together to share the cost and use of a NIST traceable thermometer that is also an option. Be sure the paperwork does not get lost in the transport of thermometer(s) between each plant. The Department recommends using extreme care in transporting any thermometer - both to avoid shocking it and to avoid breakage of a mercury thermometer.

- Option 4: Pay a contractor to bring a NIST certified thermometer to your lab and compare its readings to the readings from your thermometers. Remember, the NIST certified thermometer must have been certified for the appropriate temperature point and you must keep a written record of this comparison work. This includes a copy of the NIST certification for the thermometer used to check your thermometers and of the readings from both, the date the comparison was made and the signature of the person who did the comparison work.

If you have question about any of these options or other QA/QC issues, please be sure to contact your assigned inspector. Answers to any questions that may apply at a number of locations can be published in this newsletter so we can all benefit.

Beth DeHaas

Temperature Control

Many of the analytical techniques used in a laboratory are temperature dependent. In addition, the shelf life of many reagents and chemicals is dependent on storage temperature. Common laboratory instruments and the corresponding

temperatures for accurate pollutant analytical testing are as follows:

- Sample refrigerator temperature must be maintained at $\leq 4^{o}C$
- BOD_5 incubator temperature must be maintained at $20 \pm 1^{o}C$
- TSS drying oven temperature must be maintained between $103\text{-}105^{o}C$
- Fecal coliform water bath temperature must be maintained at $44.5 \pm 0.5^{o}C$
- E.Coli temperature must be maintained at $35 \pm 0.2^{o}C$ for 2 hours in an air incubator then 22 hours in a water bath at $44.5 \pm 0.2^{o}C$.

Daily temperature logs should be maintained for these laboratory instruments. Thermometers with a temperature range from $0\text{-}110^{o}C$ can be used to monitor temperature during routine testing. A specific fecal coliform or E.Coli bath thermometer must be used to measure bath temperature. Thermometers should be calibrated once per year with an NIST or equivalent certified thermometer and then documented as to date, time and persons performing the calibration (See the accompanying Article of NIST Certification for more information on this). The temperature control devices on a refrigerator, incubator or oven should not be relied upon because they can be inaccurate. Temperature control should be monitored continuously with a calibrated thermometer stored within the unit. Thermometers should be dedicated to each oven, incubator or refrigerator Temperature Control

Don Albert

Answers to *For Practice:*

1. a. It becomes very difficult to pump sludge, even using positive displacement pumps, when the concentration reached 10%.

2. b MLVSS stands for Mixed Liquor Volatile Suspended Solids. The MLVSS is a gross measure of the portion of the sludge in the aeration basin, which is alive and actually taking up waste from the influent. By maintaining a constant concentration of MLVSS in the aeration basin, the operator ensures that there is a population of live, hungry bugs ready to eat the pollutants in the influent

3. b 1 mg (milligram) is 1/1000 of a gram. 1 liter of water has, by definition, a mass of 1000 grams. 1000 grams equals 1,000,000 milligrams. Thus, 1 milligram is 1/1,000,000 of a liter so 1 mg/L = 1 part per million

4. d Pounds = dosage (in mg/L) x Flow (in MGD) x 8.34 lbs/gal x days
   Pounds = 6 mg/l x 2.5 MGD x 8.34 lbs/gal x 30 days = 3,753 pounds

Spring Certification Exam

Those of you who signed up for the Spring Wastewater Operator Certification Exam should have received your notification letter by now. If you signed up to take the test and haven't heard from us, call Leslie Rucker at 287-9031 or Dick Darling at 287-7806 as soon as possible. If you missed out on the spring exam, study up and take it in the fall.

DMR Lag

When the Department renews discharge permits, the parameter limits may change or parameters may be added or deleted. In some cases, it is merely the replacement of the federally issued NPDES permit with a state-issued MEPDES permit that results in different limits. When the new permit is finalized, a copy of the permit is passed to our data entry staff for coding into EPA's Permits Compliance System (PCS) database. PCS was developed in the 1970's and is not user-friendly. Entering or changing parameters can take weeks or even months.

This can create a lag between the time your new permit becomes effective and the new permit limits appearing on your DMRs. If you are faced with this, it can create three different situations that have to be dealt with in different ways.

1. If the parameter was included on previous DMRs, but only the limit was changed, there will be a space for the data. Please go ahead and enter it. When the changes are made to PCS, the program will have the data and compare it to the new limit.

2. When a parameter is eliminated from monitoring in your new permit, but there is a delay in changing the DMR, you will have a space on the DMR that needs to be filled. For a parameter that has been eliminated, please enter the space on the DMR for that parameter only with "NODI-9" (No Discharge Indicator Code #9). This code means monitoring is conditional or not required this monitoring period.

3. When your new permit includes parameters for which monitoring was not previously required, and coding has not caught up on the DMRs, there will not be any space on the DMR identified for those parameters. In that case, please fill out an extra sheet of paper with the facility name and permit number, along with all of the information normally required for each parameter (parameter code, data, frequency of analysis, sample type, and number of exceedances). Each data point should be identified as monthly average, weekly average, daily max, etc. and the units of measurement such as mg/L or lb/day. Staple the extra sheet to the DMR so that the extra data stays with the DMR form. Our data entry staff cannot enter the data for the new parameters until the PCS coding catches up. When the PCS coding does catch up, our data entry staff will have the data right at hand to do the entry without having to take the extra time to seek it from your inspector or from you.

EPA is planning significant improvements for the PCS system that will be implemented in the next few years. These improvements should allow us to issue modified permits and DMRs concurrently. Until then we appreciate your assistance and patience in this effort.

Phil Garwood